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LANTERN FISHES FROM "INVESTIGATOR" STATION 670, INDIAN OCEAN

By Rolf L. Bolin

Among material submitted for investigation to Dr. Albert W. Herre by the Indian Museum were 55 fishes of the family Myctophidae. Knowing of my interest in the group, Dr. Herre was kind enough to turn these fishes over to me for study. While they were all small and most of them not in the best of condition, only three of the specimens proved to be undeterminable. One of these was a specimen of the genus Diaphus from "Investigator" station 461, the other two were small specimens of the same genus from station 670. The latter station, in the Indian Ocean some 200 miles off Cape Cormorin, Lat. 5° 56' 00" N., Long. 76° 22' 00" E., yielded all of the remaining specimens which are reported upon in this paper. The gear was operated between 200 fathoms and the surface. The date was April 24, 1924.

Myctophum lychnobium, new species

Body slender throughout. Upper anterior profile of head marked by slight concavities over anterior edge of orbit and upper end of preopercle. Snout steep, bluntly rounded, very slightly protruding; mouth barely inferior. Maxillary slightly expanded posteriorly, its posteroventral margin curved slightly downward, its end sharply rounded, extending well beyond eye, about 0.4 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Narrow bands of cardiform teeth on premaxillaries and dentaries. Eye rather small, orbital diameter about equal to length of snout and 4.6 in head; upper orbital margin strongly developed, the edge of the frontal extending anteriorly as a well defined lateral ridge as far as the vertical of the posterior nostril. Anterior border of preopercle only slightly oblique, its upper end a full orbital diameter behind eye; opercular margin rather evenly rounded. Gill rakers well developed. I have not attempted to count the gill rakers nor to examine the vomerine and palatine teeth for fear of damaging the small unique type.

Fin formula: D. 15; A. 19; V. 8. Dorsal origin on a vertical about midway between tip of snout and next to last AOp; dorsal base 1.5 in anal base. Anal origin slightly in advance of end of dorsal base. Adipose fin large, directly over end of anal base. Pectoral base about midway between snout and AOa_2, rather high, its upper end about midway between dorsal and ventral body margins. Pelvic base a little in front of dorsal origin, fin extending about to anus. All of the fins except the pelvics broken. Scales cycloid, 38 or 39 in lateral line.

Measurements of type in mm. and per mille of standard length (figures in

parentheses are per mille): length of head 4.6 (298); length of maxillary 2.9 (187); diameter of orbit 1.0 (65); distance from dorsal to pelvic 3.3 (213); distance from dorsal to anal 3.7 (232); depth of caudal peduncle 1.1 (71); distance from snout to dorsal 6.9 (445); length of dorsal base 2.2 (142); distance from snout to anal 8.5 (549); length of anal base 3.5 (226); distance from snout to end of adipose base 12.3 (794); distance from snout to pectoral 4.6 (298); distance from snout to pelvic 6.5 (420); length of pelvic 1.7 (110).

A small round Dn directed forward and a slightly larger oval Vn directed downward, the two organs connected by an apparently tubular streak of black tissue which borders the orbit anteriorly. Op_1 small but distinct, opposite lower posterior angle of maxillary; Op_2 slightly larger than neighboring organs, separated from Op_1 by a distance about equal to its own diameter. PLO slightly behind PVO_1, markedly closer to pectoral base than to lateral line. PVO_1 directly over PO_2, on a

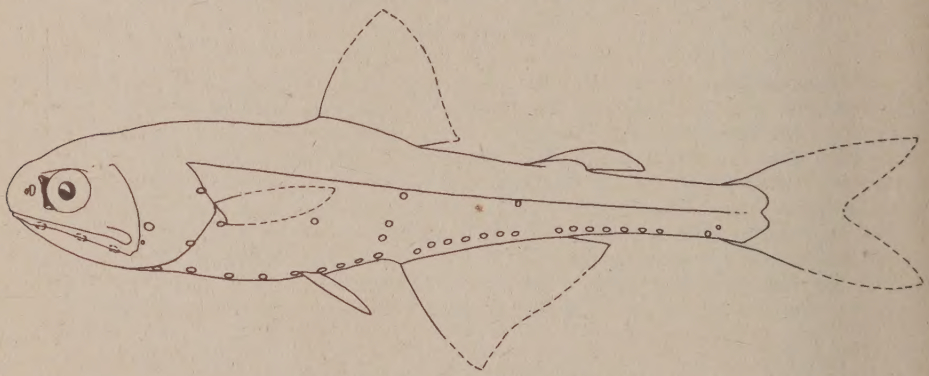

Fig. 1. *Myctophum lychnobium*, new species.

line connecting PO_1 and PVO_2 which is immediately in advance of lower pectoral rays and well in advance of PO_3. Five PO; PO_1 slightly behind Op_2; PO_5 immediately anterior to base of outer pelvic rays; first two PO interspaces subequal and a little larger than the last two; from ventral view the first, second, third and fifth organs form gently diverging straight lines, the fourth organs slightly displaced toward the midline. VLO about over posterior end of pelvic base, somewhat closer to lateral line than to pelvic fin. Four VO about evenly spaced; VO_1 just posteromesad to base of inner pelvic rays; from ventral view all organs form very slightly curved lines with the concavity directed mesad. SAO forming a straight line which passes about through anterior border of VO_4; SAO_1 over and slightly behind VO_4; SAO_2 about twice as close to SAO_1 as to SAO_3 which is about over anal origin and almost in contact with lateral line. AO 7 + 7, about evenly spaced; AOa_1 depressed, its upper edge about on a line passing through the ventral margins of the remaining organs in this series; AOp_1 directly over base of next to last anal ray, separated from last AOa by an interspace equal to 0.6 depth of caudal peduncle. A single Pol directly over last AOa, well in front of adipose fin and in contact with lateral line. Prc_1 near ventral body margin, separated from last AOp by an interspace about 1.5 times as wide as that between last AOa and first AOp; Prc_2 reduced in size, slightly elevated but markedly closer to base of lower caudal rays than to lateral line. No indication of supra- or infracaudal luminous glands.

Color a rather uniform brown.

Through the use of most modern keys this species would be determined as *Myctophum affine* (Lütken) since the photophores and the meristic characters of fin rays and scales are in almost perfect accord in both forms. Nevertheless, the specimen at hand undoubtedly represents another species which differs strongly from the fish described by Lütken in the much more slender form and in the relationships of the much smaller eye to the snout, maxillary and preopercle. The question immediately arises: could the specimen represent a species which has already been described and erroneously placed in the synonymy of *M. affine*? On the basis of the original figure and the unsatisfactory type description, *M. nitidulum* Garman appears to be the only form to which the present specimen might logically be assigned. In case Brauer (1906), Gilbert (1908) and Parr (1928) have all erred in considering *M. nitidulum* to be conspecific with *M. affine*, perhaps such a course should be followed. However, I have four specimens from off the west coast of Central and South America which appear to be the true *M. nitidulum*, if that species should be valid, but on which a report is being held in abeyance until I have had opportunity to examine Garman's type. Among them is a specimen of almost exactly the same size as the type of *M. lychnobium* and direct comparison of these two fishes reveals such striking differences that I do not hesitate to call them distinct species. In the specimen from the Indian Ocean the eye is smaller, the maxillary longer and narrower, the caudal peduncle markedly longer, the adipose fin is over instead of in advance of the end of the anal base, the Pol is well in front of the adipose fin instead of under the middle of its base, the AOa-AOp interspace is farther forward, while all of the body photophores are markedly smaller and the color of the body is darker.

The type and only known specimen, evidently a juvenile, is 15.5 mm. in standard length. It has been deposited in the Indian Museum in Calcutta.

Lychnobium, one who lives by lamplight, who turns night into day.

Benthosema fibulata (Gilbert and Cramer)

Myctophum fibulatum Gilbert and Cramer, 1896, p. 411, pl. 38, fig. 2 (not fig. 3) ("Albatross" station 3467, Kaiwi Channel, Hawaii, Lat. 21° 13' 00" N., Long. 157° 43' 37" W.).

Three small specimens, 11.4 to 15.6 mm. in standard length are assigned to this species. They differ considerably from the description and figure of the type, particularly in having the PLO well below the lateral line although much closer to the lateral line than to the pectoral base, and in having the SAO_1 more elevated and falling well above a line through the VO_2 and SAO_2. Apparently these photophores are quite variable. I have examined several specimens from Hawaii, the region from which the type was taken, as well as several from the Philippines, and in all of these the PLO is well below the lateral line but about twice as close to it as to the pectoral base. Adult material from Hawaii agrees with the type in having the VO_2, SAO_1 and SAO_2 about in line, but in Philippine specimens the SAO_1 falls a little above a line through VO_2 and SAO_2, and in juveniles from Hawaii as well as in the small specimens from the "Investigator" collections the SAO_1 is higher still.

Our knowledge of *Benthosema fibulata* is far from satisfactory. Whether the rather widely divergent specimens assigned to it actually represent a single highly variable species or a group of very closely related species must await the analysis

of extensive material collected over a wide area. For the present it seems best to consider at least three nominal species to be direct synonyms of this form. *B. pinchoti* Fowler appears not to differ from the type in any significant character, while *Myctophum renschi* Ahl and *M. hollandi* Jordan and Jordan, each known from a single individual, seem to be based upon anomalous specimens in which the VO_1 or VO_2 is abnormally missing. On the other hand, the extremely low position of the PLO and the comparatively great elevation of the Prc_2 may gain full specific standing for *M. fibulatum proximum* Parr.

Two of the specimens have been deposited in the Indian Museum; one is No. 40370 in the Stanford Natural History Museum.

Diogenichthys panurgus, new species

Body robust throughout. Upper anterior profile slightly concave over anterior part of orbit; snout bluntly rounded, slightly protruding in males, the mouth barely inferior; in females the snout does not protrude and the mouth is usually strictly terminal. Maxillary short, extending about to vertical of posterior edge of eye, approximately 0.2 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit; its posterior 0.4 broadly expanded, the end bluntly rounded. Eye large, orbital diameter about twice length of snout, 3.0 (2.8-3.3) in head. Opercular margin usually ending in a blunt point, sometimes almost evenly rounded. Gill rakers long, those at angle equal to about 0.5 diameter of orbit; 2 (2-3) + 1 + 8 (8-9) on first arch.

Fin formula: D. 11 (10-12); A. 15 (15-16) P. 11; V. 8. Dorsal origin about midway between snout and base of caudal; dorsal base 1.7 (1.6-1.8) in anal base. Anal origin somewhat in advance of end of dorsal base. Adipose fin well in advance of end of anal base. Pectoral base midway between snout and a point somewhere between AOa_1 and AOa_3; fin extending about to anal origin. Pelvic base on a vertical about midway between pectoral base and dorsal origin, or somewhat closer to dorsal; fin extending about to anus. Scales cycloid, deciduous, almost all of them lost in the type material.

Measurements in per mille of standard length based on eight specimens 14.3 to 17.3 mm. in standard length: length of head 318 (303-326); length of maxillary 158 (155-160); diameter of orbit 107 (97-114); distance from dorsal to pelvic 262 (243-282); distance from dorsal to anal 258 (243-270); depth of caudal peduncle 105 (93-117); distance from snout to dorsal 511 (500-528); length of dorsal base 141 (131-153); height of dorsal 180 (166-194); distance from snout to anal 611 (584-625); length of anal base 234 (222-243); height of anal 153 (133-171); distance from snout to end of adipose base 792 (778-800); distance from snout to pectoral 342 (327-361); length of pectoral 302 (290-313); distance from snout to pelvic 442 (431-452); length of pelvic 132 (124-145); length of caudal 268 (250-285).

A well developed Dn, this organ of small size in females but greatly enlarged in males, being equal to or larger than laminated rosette of nasal tissue. The extreme ventral corner of the Dn in the males appears to be somewhat differentiated from the major mass of luminous tissue and to be separated from it by a thin sheet of black pigment to form a small, oval, semi-independent organ. This organ, possibly representing a Vn, is on the level of the middle of the nasal rosette; it is usually not visible from the lateral aspect but must be examined from in front. A similar organ may be made out in most males of *D. laternatus* (Garman). A small but well developed Op_1 about opposite middle of maxillary expan-

sion; Op_2 approximately the same size as general body photophores, well behind Op_1 and separated from it by a space equal to two or three times its own diameter. PLO directly over or somewhat in advance of PO_3, about midway between pectoral base and lateral line. PVO_1 usually on a vertical somewhat closer to PO_2 than to PO_3, rarely directly over middle of second PO interspace, very slightly below level of PVO_2 which is at base of lower pectoral rays. Five PO, the first two interspaces usually somewhat larger than the last two; from ventral view the middle three organs form approximately straight and parallel lines, the first organs displaced toward the midline, the last organs slightly divergent and located in front of outer ventral rays. VLO over or very slightly behind ventral base, midway between ventral base

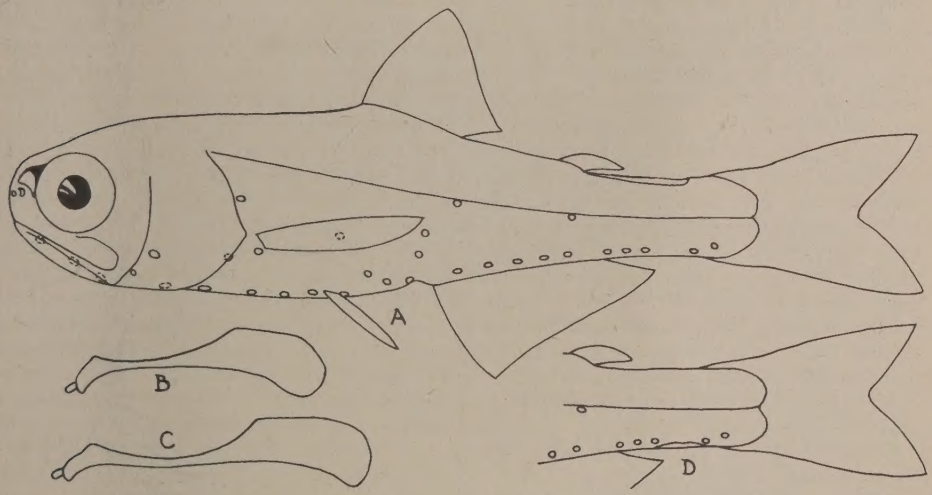

Fig. 2. A. *Diogenichthys panurgus*, new species, male. B. Maxillary of *D. panurgus*. C. Maxillary of *D. laternatus*. D. Caudal peduncle of *D. panurgus*, female.

and lateral line or slightly below this point, forming a straight line with the two PVO. Four VO evenly spaced or with first interspace enlarged; VO_1 behind base of inner ventral rays; VO_2 elevated but not to a line passing through the two PVO; from ventral view the last three VO form almost straight converging lines. SAO forming a straight line or very obtuse angle with the opening directed backward; SAO_1 slightly behind VO_4, about midway between this organ and SAO_2, the three organs forming a straight line, the interspaces between them about half as great as that between SAO_2 and SAO_3 which is almost directly above AOa_1 and in contact with lateral line. Six (5-6) + 3 (2-4) AO, all in line, the first one or two interspaces often enlarged; AOp_1 very slightly behind base of last anal ray, separated from last AOa by an interspace equal to about 0.3 depth of caudal peduncle. One Pol slightly behind last AOa, under or slightly behind posterior part of adipose base and in contact with lateral line. Prc_2 very slightly elevated, much closer to ventral margin than to lateral line, separated from Prc_1 by an interspace less than half as wide as that between last AOp and Prc_1. Males with a large undivided supracaudal luminous gland extending from adipose base to vertical of Prc_1; the width of the gland so great that its lateral edges protrude slightly beyond the walls of the

caudal peduncle immediately below them; gland bordered by black tissue which is evidently silvery on inner surface. Females with a narrow infracaudal luminous gland extending from last AOp to first Prc; slight indentations of its lateral margin suggest that it may represent about three "luminous scales."

Color a rather uniform pale brown; such scales as remain are silvery.

This species is extremely closely related to *Diogenichthys laternatus* and may, indeed, represent a subspecies of that form. In deciding to accord it tentative full specific standing, I have been influenced by four characters which very readily distinguish it from those specimens of *D. laternatus* which are available to me: 1) The maxillary is markedly shorter than in *D. laternatus*, measuring about 158 instead of about 189 per mille of standard length. Its length enters about 2.0 instead of 1.7 in length of head. In an attempt to check this point, I dissected out the maxillary on one side of one specimen of each species, selecting individuals of the same size. Figures 2 B and C, drawn to the same scale, show the striking differences in the size of the two bones, in the proportions between the shaft and the blade, in the abruptness with which the blade expands, and in the proportions between the depth and length of the blade. 2) The supracaudal luminous glands of males, instead of originating at least half the length of the gland behind the adipose fin and being equal to or shorter than the diameter of the eye, as in *D. laternatus*, originate immediately behind the adipose base, are markedly longer than the orbital diameter and cover practically the entire dorsal surface of the caudal peduncle. It should be noted that figs. 15 B and C in Bolin, 1939, give an erroneous impression in regard to the comparative lengths of the eye and gland of *D. laternatus*. I have rechecked the material upon which these figures were based. 3) The infracaudal luminous glands of females always originate opposite the last AOa and extend over the entire length of the AOp-Prc interspace, instead of always originating a photophore diameter or more behind the last AOp and being considerably shorter than the interspace. 4) Specimens are mature and have fully developed secondary sex characters at a standard length of 14.3 mm. They probably mature even earlier than this since Brauer (1906), in reporting at least in part on this species under the name *Myctophum laternatum*, stated that the glands were not developed in specimens "die weniger als 1,2 cm lang waren." On the other hand, although specimens of the true *D. laternatus* 16.6 and 17.2 mm. in standard length can be determined as males by the somewhat enlarged Dn photophores, they show no luminous tissue on the caudal peduncle, nor does any trace of these glands occur in specimens 17.1 and 18.0 mm. in standard length, which are probably females, while in a 20.6 mm. male and in a 20.2 mm. female luminous tissue may be detected but the glands are small and incompletely developed. Thus *D. panurgus* matures at a length only about 70 per cent as great as that of the maturing *D. laternatus*, and it is even possible that the value should be closer to 60 per cent.

These characters appear to me to be adequate grounds for considering the two forms to be distinct species. However, there are several additional features which tend to differentiate them, but in which the two species overlap somewhat. *Diogenichthys panurgus* has, on the average, fewer dorsal and anal rays, photophores and gill rakers; the orbit averages larger; the depth of the body, as expressed by the distances between the dorsal and the pelvic and anal fins, is slightly greater, while the origins of the dorsal and anal fins are somewhat farther posterior than in *D. laternatus*.

The type, a male specimen 16.3 mm. in standard length, and three paratypes have been deposited in the Indian Museum; four paratypes are No. 40371 in the Stanford Natural History Museum.

Πανουργος, a rascal.

Diaphus splendidus (Brauer)

Myctophum (*Nyctophus*) *splendidum* Brauer, 1904, p. 399, fig. 7 (several stations in the Atlantic and Indian Oceans).

One specimen, 18.9 mm. in standard length, is tentatively assigned to this species. The VLO, SAO_3, Pol and Prc are slightly lower than is indicated in the original description and figure presented by Brauer, and the pelvic fins are somewhat in advance of the dorsal origin instead of directly under it. In these respects the specimen is similar to *Diaphus signatus*, but it differs from Gilbert's (1908) description and figure in having the PLO closer to the pectoral base than to the lateral line. In describing *D. signatus*, Gilbert stated that it differed from *D. splendidus* in the smaller head, shorter snout, less elevated interorbital region and the more anterior insertion of the pelvic fins. Reducing Gilbert's measurements to terms comparable with Brauer's, we find that the head enters the standard length 3.6 instead of 3.2 to 3.5 times and that the snout measures 1.6 instead of 1.5 in the eye. While Gilbert claims that the interorbital region scarcely protrudes above orbital rim, his figure shows a protrusion almost equal to the width of the iris and barely less than that shown by Brauer in the figure of *D. splendidus*. All of these differences are so slight that they may logically be accepted as normal individual variations. The anterior insertion of the pelvic fins then remains as the primary differentiating character and, due to the difficulty of estimating a true perpendicular on a fish, I consider this character, by itself, to be of rather dubious validity. Rather than describe a new species in a genus in which far too enthusiastic description of new species has already brought an approach to systematic chaos, I prefer to consider my small specimen as a connecting link between *D. splendidus* and the nominal *D. signatus*, and to give it the older name.

The specimen has been deposited in the Indian Museum.

Diaphus regani Tåning

Diaphus regani Tåning, 1932, p. 139, fig. 12 ("Dana" station 3611, off New Caledonia, Lat. 20° 53' 12" S., Long. 164° 03' 18" E.).

A single specimen, 15.8 mm. in standard length, is placed in this species although it differs in several respects from the description and figure of the type, which measured 59 mm. in standard length. The most notable differences are the markedly larger head of the specimen at hand, which measures 2.9 instead of 3.4 in standard length, and the greater depth of body, for which I get a value of 4.0 instead of 4.9 in standard length. These differences may readily be due to the great discrepancy in size between my specimen and the type. Correlated with the large head, the dorsal origin is relatively farther posterior, lying midway between the tip of the snout and the tip of the adipose fin instead of midway between the snout and adipose origin. The photophores are a little larger than shown in the figure of the type but their arrangement matches fairly well the pattern depicted by Tåning. On the left side there are six AOp, the penultimate one strongly elevated, its upper edge about midway between lateral line and ventral margin of peduncle, the ultimate one reduced in size and very slightly higher. On the right side there are five AOp and only the last one is elevated. The PLO is lower than in the type and is a little closer to the pectoral base than to the lateral line. The

relative position of the PLO has been accorded great importance in most systematic works on the genus and frequently serves as one of the main diagnostic characters in the separation of species. While its position is often of major significance, there can be little doubt that it displays considerable variability in some species and I consider *D. regani* to be one of these.

The specimen has been deposited in the Indian Museum.

Diaphus rafinesquii (Cocco)

Nychtophus rafinesquii Cocco, 1838, p. 20, pl. 3, fig. 7 (San Raineri).

Two small specimens, 9.0 and 10.4 mm. in standard length, are tentatively assigned to this species. A well developed anterior So and a minute but distinguishable posterior So a little behind the center of the eye characterize the larger specimen. The smaller specimen is clearly conspecific with it, and although the luminous tissue of the posterior So is still undeveloped, its position is indicated by a streak of black pigment extending backward from the anterior So. These specimens have the posterior So too far forward to be placed in either *D. brachycephalus* Tåning or *D. richardsoni* Tåning, and their snouts are too steep and abrupt to consider allocating them to *D. anderseni* Tåning, *D. layi* Fowler, *D. aliciae* Fowler or *D. longleyi* Fowler. Of the remaining species which have been described as having two So, *D. rafinesquii* appears to be the only logical choice for assigning the specimens, for until a careful revision, based on direct comparison of numerous specimens from widely separated localities, has been accomplished, it seems advisable to follow Parr (1928) in considering *D. theta* Eigenmann and Eigenmann, *D. nanus* Gilbert, *D. holti* Tåning and *D. mollis* Taning to be synonyms of *D. rafinesquii*. To this tentative list of synonyms should be added *D. parri* Tåning and *D. kendalli* Fowler, for nothing in the descriptions and figures of these two forms provides a single adequate character for distinguishing them from *D. rafinesquii*. It is, of course, entirely possible that some or even all of these species may prove to be valid.

One of the specimens has been deposited in the Indian Museum, the other is No. 40372 in the Stanford Natural History Museum.

Genus *VESTULA*, new

Genotype *Myctophum valdiviae* Brauer.

Frontal bones expanded into a small but conspicuous, median, transparent dome into which the parietal or parapineal organ extends. Mouth large, extending far beyond orbit; maxillary abruptly expanded near its posterior end. Numerous small cardiform teeth in bands on premaxillaries and dentaries; one or two similar teeth on posterolateral angle of the chevron of the vomer; a single long series of minute teeth on palatines and a small oval patch on entopterygoids. Eyes of males much larger than those of females. Anal fin somewhat longer than dorsal, adipose far behind end of anal; pectoral fins placed high, about on axis of body; pelvics with only six rays. Lateral line absent. Dn photophore present; Vn absent; PLO far above pectoral base; PVO_2 not above pectoral base; VLO, SAO_3, Pol_2 and Prc_2 all very high, close to dorsal body margin; AOa-AOp interspace far behind end of anal base; two Prc in a vertical series. Supracaudal luminous gland present in both sexes, not extending along anterior edge of upper caudal rays, much more highly

specialized in males than in females, similar to supracaudal luminous gland of the genus Lampadena in the former sex, to that of the genus Lampanyctus in the latter; no infracaudal luminous glands present.

For the information that this genus lacks a lateral line I am greatly indebted to A. Fraser-Brunner, Esq., of the British Museum. Had it not been for him this important generic character would have escaped me entirely, since all scales have been lost from the region of the normal lateral line in all of my specimens.

This interesting monotypic genus appears to me to be intermediate between Lampadena and Lampanyctus. By this statement I do not mean to imply that either of the latter genera has evolved from the other and left Vestula as an intermediate indicator of the course of evolution, but rather that all three genera have descended from a common and not too remote ancestor, and that Vestula possesses characters indicative of relationship to each of the other two. Its relationship

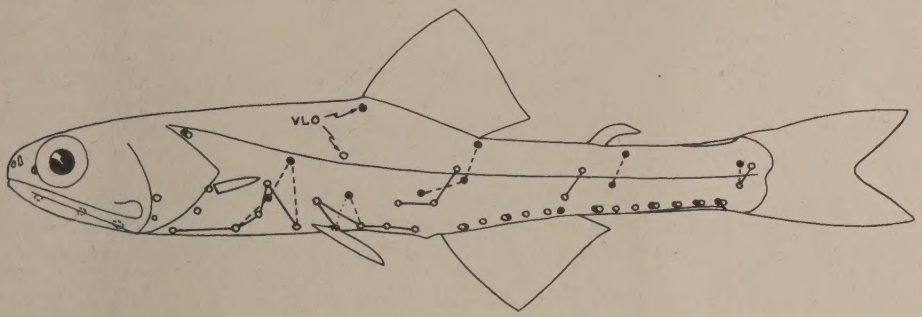

Fig. 3. A hypothetical Myctophid based primarily on *Lampanyctus mexicanus* but with the VO photophores adjusted; certain photophores of *Vestula valdiviae* superimposed in black.

to Lampadena seems clearly indicated by the peculiar structure of the luminous gland of the male. Other possible indications of relationship are the possession, in common with *Lampadena luminosa* (Garman), of a Dn, and the extremely posterior position of the AOa-AOp interspace which is duplicated elsewhere within the family only by *L. chavesi* Collett. On the other hand, the very great elevation of many photophores indicates relationship to some other evolutionary line which shows a similar trend. The line best suited for comparison is composed of *Lampanyctus microchir* Gilbert, *L. micropterus* (Brauer), *L. nigrescens* (Brauer), *L. turneri* (Fowler) and *L. mexicanus* (Gilbert), and of these the latter is most similar to Vestula in the position of the body photophores. Figure 3 represents a hypothetical Myctophid. It is a drawing of *L. mexicanus* in which the abberrant VO photophores of that form have been adjusted to fit the normal pattern in the group under discussion. The photophores of this hypothetical fish are represented as white circles; those of Vestula which do not coincide in position have been superimposed as black spots in as accurate a manner as the somewhat different shapes of the two forms will permit. Certain series of Lampanyctus photophores have been connected by solid lines and those of Vestula by broken lines in order that comparison may be more easily made. This figure presents my interpretation of the homologies of the organs in the two forms; an interpretation which differs considerably from the original one of Brauer who considered the VO_4 of Vestula to be a VLO, and the VLO

to be an entirely new organ. Considering the commonly accepted view that the posterior organs near the dorsal margin of the body are the greatly elevated SAO_3, Pol_2 and Prc_2, I can see no reason for doubting that similar extreme elevation has affected the VO_4 and VLO as well. The diagram illustrates graphically the general tendency for dorsal and posterior displacement of certain organs in Vestula. It also shows that this form has five PO, the characteristic number in *L. mexicanus* and its close relatives, as well as in most species of Lampadena, and while two of them are elevated the same is true in both *L. mexicanus* and *L. turneri*. The elevation of first VO in Vestula may seem curious at first sight, but it is evident that this organ is homologous to the VO_2 of the other forms under discussion and that the VO_1 which is always located immediately behind the ventral base has been lost, a situation unique among the species of the family, unless Ahl's *Myctophum renschi* should prove to be valid.

Vestula, a little priestess of Vesta, goddess of the hearth and its fire.

Vestula valdiviae (Brauer)

Myctophum valdiviae Brauer, 1904, p. 398, fig. 6 (numerous stations in the Atlantic and Indian Oceans).

Body slender, dorsal and ventral contours roughly parallel anterior to dorsal origin, narrowing rather abruptly under dorsal base and then tapering evenly to caudal peduncle. Upper anterior profile gently and evenly curved, but broken over anterior margin of pupil by the small abrupt dome over parietal organ. Snout rather sharply pointed; mouth terminal. Maxillary slightly but very abruptly expanded at its posterior end; extending far beyond eye, about 0.4 (in males) or 0.5 (in females) of its length lying behind a perpendicular to the mouth drawn through the posterior margin of orbit. Eye of male very large, orbital diameter 3.4 (3.2-3.6) in head; that of females small or moderate in size, 4.8 (4.6-5.0) in head. Opercular margin rounded or often truncate opposite base of pectoral. Gill rakers moderately long, those at angle equal to about 0.5 to 0.7 diameter of orbit, few in number, 2 + 1 + 7 on first arch with one or two rudimentary ones at anterior end of each limb.

Fin formula: D. 11 (10-11); A. 13 (12-14); P. 13 (12-14); V. 6. It should be noted that Brauer reports this species as having eight pelvic rays, the characteristic number for the family. These rays are very difficult to count in this small species, but in the three specimens in which I have every reason to believe my own counts to be accurate, I was unable to distinguish more than six rays. Dorsal origin midway between tip of snout and a point somewhere between last AOp and Prc_1; dorsal base 1.3 (1.1-1.5) in anal base. Anal origin under or somewhat in advance of middle of dorsal base, about under fifth to seventh dorsal ray. Adipose fin far behind end of anal base, the distance equal to or somewhat greater than depth of caudal peduncle. Pectoral base midway between snout and a point somewhere between AOa_1 and AOa_2, placed high on body, its upper end about midway between dorsal and ventral body margins or slightly higher; fin extending about to elevated VO. Pelvic base on a vertical about midway between pectoral base and dorsal origin, fin extending about to anus. Scales cycloid, 27 or 28 in longitudinal series. The scale count has been made on the basis of scale pockets which are clearly outlined by bands of enlarged and crowded melanophores, since all of the lateral scales have been lost in the specimens at hand.

Measurements in per mille of standard length based on ten specimens 18.4 to

20.4 mm. in standard length: length of head 304 (293-319); length of maxillary 211 (200-222); diameter of orbit 91 (87-98) in males, 62 (59-65) in females; distance from dorsal to pelvic 193 (180-217); distance from dorsal to anal 171 (161-180); depth of caudal peduncle 62 (57-66); distance from snout to dorsal 507 (489-520); length of dorsal base 145 (132-157); distance from snout to anal 534 (522-559); length of anal base 176 (157-195); distance from snout to end of adipose base 803 (781-833); distance from snout to pectoral 307 (292-323); length of pectoral 165 (156-173); distance from snout to pelvic 419 (403-429); length of pelvic 94 (86-108).

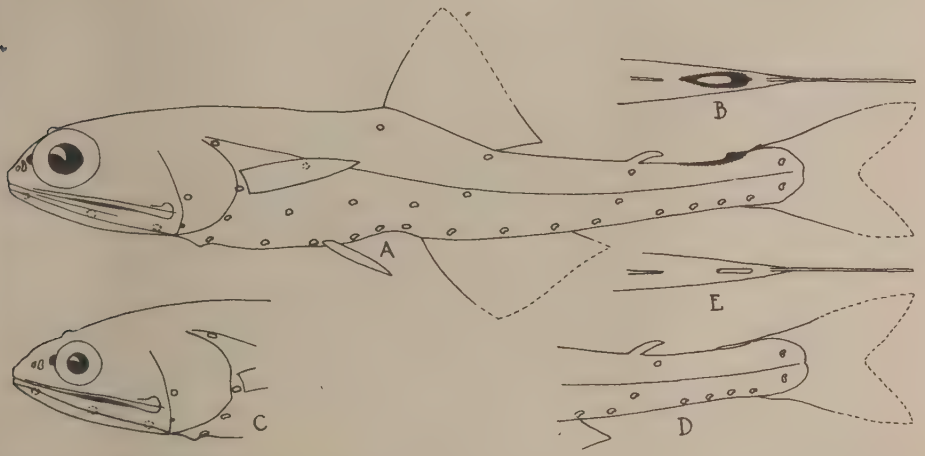

Fig. 4. *Vestula valdiviae* (Brauer). A. Adult male. B. Dorsal view of male caudal peduncle. C. Head of adult female. D. Caudal peduncle of adult female. E. Dorsal view of female caudal peduncle.

Body photophores kidney shaped, their posteroventral margins indented; this feature more strongly marked in ventral than in dorsal organs. A well developed Dn about on midline of orbit and behind upper edge of nasal capsule, placed so low that it may actually represent a slightly elevated Vn. Tiny circles of black pigment in some of the specimens indicate that Ce and Bu organs, and possibly postorbitals as well, may be present, but the material is not in good enough condition to be certain on this point. Op_1 small, often indistinct, a little below and behind end of maxillary; Op_2 about same size as neighboring organs, directly over or very slightly behind Op_1 and well below level of PVO_2. PLO usually on a vertical between PO_1 and PVO_1; sometimes directly above former organ, in contact with horizontal septum. PVO_1 about midway between PO_1 and PVO_2 but slightly posterior to a line connecting these organs, the three organs forming a gentle curve; PVO_2 immediately in front of pectoral base and slightly below its middle. Five PO; first, second and fifth PO forming almost straight parallel lines from ventral view, first interspace equal to or slightly greater than that between PO_2 and PO_5; PO_3 elevated almost to a line passing through PVO_1 and VO_1, slightly behind a line connecting PO_2 and PO_4 which is extremely high, lying about its own diameter below horizontal septum and barely in front of vertical of PO_5. VLO exceptionally elevated, lying about two or three times its own diameter directly below dorsal origin. Four VO;

VO_2 to VO_4 forming slightly converging lines from ventral view, the interspaces between them about equal to each other and to the distance from ventral base to VO_2; VO_4 on vertical of anus; VO_1 elevated to a position slightly above a line connecting PO_3 and SAO_1, barely in front of VO_2. SAO strongly angulated; SAO_1 a little behind last VO, somewhat nearer horizontal septum than ventral body margin; SAO_2 well behind AOa_1, almost in contact with horizontal septum; SAO_3 near dorsal body margin and directly under or somewhat posterior to end of dorsal base. Four (4-5) + 4 AO, all in line and very widely spaced, the interspaces of the posterior series markedly smaller than those of the anterior series; AOa-AOp interspace somewhat wider than depth of caudal peduncle, well behind end of caudal base, the next to last AOa over or somewhat anterior to base of last caudal ray. Two Pol forming an ascending arc with the last AOa; Pol_1 about its own diameter below horizontal septum or somewhat lower; Pol_2 a little closer to dorsal body margin than to horizontal septum, on a vertical somewhere between anterior end of adipose base and posterior tip of fin. On the right side of one specimen the Pol_2 is very small, poorly developed and barely above the horizontal septum. Two Prc, Prc_1 a little higher than last AOp, separated from it by an interspace equal to about 0.8 depth of caudal peduncle; Prc_2 vertically over Prc_1, the two organs equidistant from horizontal septum. Supracaudal luminous gland of males extending between verticals of first AOp interspace and last AOp; broad and protruding somewhat above general profile of peduncle posteriorly, narrowed and sunken in a groove anteriorly; walls of groove covered by heavy black pigment which in uninjured specimens is continuous with a black cap extending forward over the posterior fourth or fifth of the organ, giving the impression that the light is directed forward; this cap often thin and eroded, displaying a silvery reflecting layer underneath. Supracaudal glands of females shorter than those of males, originating over second AOp interspace, narrow throughout, not wider than a normal photophore diameter, thin and lying on the surface of the peduncle, not sunken anteriorly or protruding posteriorly, without extremely heavy pigment layer characteristic of males.

Head rather uniform brown; body paler, with scale pattern outlined by lines of aggregated and enlarged melanophores.

The collection contains 17 adults and 13 postlarvae, the latter averaging about 8 mm. in standard length. They are not in good condition and, although the fully developed photophores permit accurate specific determination of the smallest specimens, I have not deemed it advisable to attempt a description of the juvenile material. The diagnosis presented is based primarily upon the ten most perfect adults. Fifteen of the specimens have been deposited in the Indian Museum; 15 are No. 40373, Stanford Natural History Museum.

Lampanyctus steinbecki Bolin

Lampanyctus steinbecki Bolin, 1939, p. 140, fig. 23 (off Lone Point, Santa Catalina Island, California).

Two specimens, 18.7 and 26.3 mm. in standard length, agree quite well with the description and figure of the hitherto unique type. Although both specimens are rather strongly bent in the middle in such a way that measurements may suffer slightly in accuracy, I deem it advisable to present a list of counts and measurements in per mille of standard length based on all three known specimens in order that some idea may be gained of the limits of variation within the species: D. 13 (12-13); A. 17 (16-18); P. 13 (12-14); V. 8; Ll. 36; gill rakers 5 (4-6) + 1 + 9

(8-10). Length of head 316 (296-332); length of maxillary 232 (222-241); diameter of orbit 59 (54-65); distance from dorsal to pelvic 181 (171-190); distance from dorsal to anal 223 (211-232); depth of caudal peduncle 79 (67-90); distance from snout to dorsal 494 (484-508); length of dorsal base 153 (138-160); height of dorsal 202 (190-214); distance from snout to anal 577 (566-588); length of anal base 203 (193-217); height of anal 158 (144-172); distance from snout to end of adipose base 812 (796-834); distance from snout to pectoral 327 (296-348); length of pectoral 293 (289-297); distance from snout to pelvic 440 (414-455); length of pelvic 144 (138-150).

In the larger of the two specimens from the Indian Ocean the gill raker at the angle of the first arch is fully as long as the diameter of the orbit. A few of the photophores vary slightly from those of the type: the Op_2 is slightly behind instead of slightly in front of the Op_1, the lower end of the strongly inclined preopercle being more sharply curved; PVO_1 is a little closer to PO_2 than to PVO_2; in both specimens there are six instead of five AOa; in the larger specimen the AOp_1 is almost over the base of the last anal ray instead of well behind it.

The larger specimen has been deposited in the Indian Museum, the smaller one is No. 40374, Stanford Natural History Museum.

Lampanyctus stilbius Gilbert

Lampanyctus stilbius Gilbert, 1908, p. 235, pl. 6 ("Albatross" hydrographic station 3798, off Cape Martin, Nukuhiva Island, Marquesas Group).

Two specimens 10.8 and 16.9 mm. in standard length, are assigned to this species. The smaller one is so twisted and eroded that it yields little information of value but the legible details indicate that it is conspecific with the larger individual. The latter specimen differs from Gilbert's figure in some minor points: the PVO_1 is slightly in front of the PVO_2 instead of barely behind it, the first PO interspace is slightly shorter instead of barely longer than that between PO_2 and PO_5, the first AO interspace is somewhat enlarged, there are only three Prc (evidently the number on the right side of the type) and the second one is slightly elevated, while there are two supra- and three infracaudal luminous scales instead of four of each. The eye measures 3.3 in head, the pelvics are inserted slightly in advance of the dorsal origin and there are five instead of four VO. In these three respects the specimen differs from the type description but agrees almost perfectly with the figure. Gilbert stated that the integument was largely rubbed off the type and while he found luminous scales only on the caudal peduncle he surmised that they probably occurred on the bases of the dorsal, anal and pelvic fins as well. Such is the case, as the specimen under discussion has two small luminous scales at the base of the dorsal, two at the anal, one at the pelvic and, in addition, similar scales above the pectoral base and below the PVO_1. A clearly defined but minute photophore about on the vertical of the anterior edge of the pupil and midway between the orbital rim and the end of the median ethmoid crest appears to represent the much reduced and displaced Dn. Still smaller organs over the posterior margins of the pupil and orbit form a series which tends to connect the Dn with the postorbitals. A number of minute scattered photophores, mentioned by Gilbert, may be detected. Enough of them can be seen to indicate that their pattern is similar to that in *Lampanyctus fraser-brunneri*, described below. They also occur in *L. photothorax* Parr.

The occurrence of luminous scales at the pectoral base and PVO_1 immediately

suggests that the specimens might belong to *L. photothorax*. However, the eye is markedly smaller (3.3 or more instead of 2.7-2.9 in head), the lateral line scales higher (more instead of less than 0.5 depth of caudal peduncle), the interorbital space is narrower and the snout more pointed than in Parr's species. The last two differences are not amenable to accurate measurement but through the courtesy of Dr. Daniel Merriman and Dr. Yngve Olsen I have been able to examine almost all of Parr's material and, when specimens of both species are directly compared, the differences become evident. The only other member of the genus with postorbitals which has been known until the present, is *L. longipes* (Brauer). This is at once ruled out of consideration by the fact that it has no Vn but possesses a conspicuous Dn immediately above the nasal organ.

The larger specimen has been deposited in the Indian Museum, the smaller one is No. 40375, Stanford Natural History Museum.

Lampanyctus fraser-brunneri, new species

Body moderately robust throughout. Upper anterior profile broken over front part of eye by a slight depression at end of median ethmoid keel; snout rather steep, bluntly rounded; mouth terminal: maxillary slightly and very gradually expanded posteriorly, extending a little beyond eye, less than 0.3 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Narrow bands of cardiform teeth on premaxillaries and dentaries; about two similar teeth on each side of vomer; palatine teeth in a single series; a large oval patch of minute teeth on pterygoids. Eye of moderate size, diameter of orbit 3.0 to 3.2 in head. Opercular margin ending in a broad truncated flap, slightly concave just opposite pectoral base. Gill rakers moderately long, the one at angle equal to about 0.6 diameter of orbit, 4 + 1 + 11 on first arch with two or three small rudimentary ones on anterior part of each limb.

Fin formula: D. 12; A. 14; P. 13; V. 8. Dorsal origin on a vertical midway between snout and a point somewhere between last AOp and Prc_2; dorsal base 1.2 or 1.3 in anal base. Anal origin slightly behind end of dorsal base, its end under or slightly behind end of adipose base. Pectoral base midway between snout and a point somewhere between AOa_1 and AOa_2. Pelvic base directly under or very slightly in advance of dorsal origin; fin extending almost to anal origin. Scales cycloid, 33 in lateral line, those on caudal peduncle enlarged, covering about 0.6 or 0.7 of its depth.

Measurements in per mille of standard length based on two specimens 15.3 and 17.7 mm. in standard length: length of head 339 (333-345); length of maxillary 200 (198-203); diameter of orbit 109 (107-111); distance from dorsal to pelvic 200 (196-203); distance from dorsal to anal 258 (255-260); depth of caudal peduncle 104 (96-111); distance from snout to dorsal 474 (458-490); length of dorsal base 148 (144-153); distance from snout to anal 647 (627-667); length of anal base 186 (181-190); distance from snout to end of adipose base 802 (774-830); distance from snout to pectoral 343 (333-353); distance from snout to pelvic 470 (463-477); length of pelvic 167 (164-170).

A well developed Vn opposite lower part of nasal organ. Dn represented by a small cup of black pigment barely behind vertical of anterior margin of eye and slightly above upper edge of pupil, a diffuse patch of luminous tissue extending forward from it; a similar Suo behind upper posterior margin of orbit and a minute photophore between them and slightly in front of middle of eye. An arc of three well defined photophores just behind orbit, increasing in size from upper to lower.

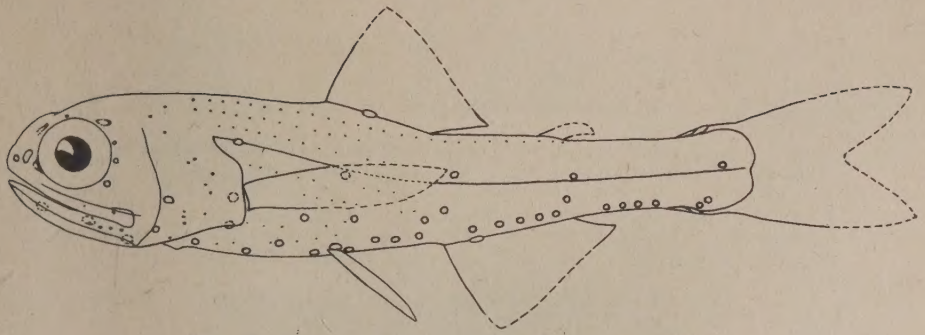

Fig. 5. *Lampanyctus fraser-brunneri*, new species.

Op_1 behind and below end of maxillary; Op_2 somewhat behind Op_1, separated from it by a space equal to two or three times its own diameter. PLO over or slightly in front of PVO_2, directly on lateral line. PVO_1 somewhat in advance of PVO_2, about midway between ventral body margin and PVO_2 which is a little in front of middle pectoral rays. Five PO; PO_2 slightly closer to PO_1 than to PO_5, these three organs forming very slightly diverging straight lines from ventral view; PO_3 elevated to a line between PVO_1 and PO_5; PO_4 elevated about to a line through PVO_2 and VO_2. VLO barely in front of VO_1, in contact with lateral line. Five VO; VO_1 directly behind inner ventral rays, VO_2 elevated to a line between PO_4 and SAO_1, last three organs forming gently converging lines from ventral view, next to last interspace smaller than last. SAO angulated; SAO_1 over and slightly behind VO_5; SAO_2 about over anal origin, midway between lateral line and ventral line of organs; SAO_3 somewhat behind SAO_2, clearly above lateral line. AO 5 + 4, all in line, first AOa interspace enlarged; AOp_1 well behind end of anal base, separated from last AOa by an interspace equal to about 0.6 depth of caudal peduncle. Two Pol forming an ascending arc with last AOa; Pol_1 somewhat closer to last AOa than to Pol_2 which is directly over or slightly behind end of anal base and immediately above lateral line. Three Prc separated from last AOp by an interspace slightly smaller than that between last AOa and AOp_1; Prc_2 close above and behind Prc_1; Prc_3 a little behind Prc_2 and immediately above lateral line. Numerous tiny photophores on head and body, perhaps under every scale in perfect material. Two supra- and two or three infracaudal luminous scales extending from about one photophore diameter behind last AOp to vertical of Prc_1 and covering surface of upper and lower caudal rays. A similar scale at base of dorsal, anal and pelvic; none at pectoral or at PVO_1.

Color a rather uniform brown.

This form is very closely related to all other species of Lampanyctus with postorbital photophores. It differs from *L. longipes* in having a Vn; from *L. photothorax* in lacking luminous scales above the pectoral base and below the PVO_1, in its smaller eye and the greater enlargement of the scales on the caudal peduncle; from *L. stilbius* in lacking the same luminous scales, in the blunter, more rounded head and in having the Dn less strongly displaced and located almost on the vertical of the anterior orbital margin instead of above the anterior edge of the pupil.

The type has been deposited in the Indian Museum, the smaller paratype is No. 40376 in the Stanford Natural History Museum.

Named for A. Fraser-Brunner, Esq., whose forthcoming report on Myctophids from the "Discovery" collections will do much to clarify the systematics of this interesting family.

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